30 Towards resilient and low-carbon cities

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Variations among cities of the developing world in terms of per-capita income, exposure to climate vulnerabilities, and GHG emissions levels are very significant and have to be taken into account in order to support their active engagement in global climate action. Ninety per cent of all urban growth by mid-century will occur in the developing world, and this build-up will require great quantities of energy and natural resources, further depleting the carbon budget. These cities will play an ever-greater role in global GDP generation and GHG emissions, and their exposure to climate change impacts will also increase. Urban climate action in the developing world will require good governance, technical capabilities and financial support. In view of the multiple priorities facing city governments, climate adaptation has to be mainstreamed within the sustainable provision of urban services and the build-up of urban resilience to natural hazards. Similarly, GHG mitigation should be embedded within green growth and urban welfare strategies, driven as much by quality of life goals as by climate protection considerations. Compact urban growth, connected infrastructure and coordinated governance can provide the way forward, and the resulting urban morphology can greatly contribute to reducing urban emissions. Further co-benefits can be obtained by integrating mitigation and adaptation strategies at the urban scale. Some cities in OECD countries are achieving significant GHG reductions and showing that a post-carbon urban future is possible. International city networks have emerged as vehicles for innovation sharing, learning, and advocacy for the recognition of cities in global climate action. For further action to take off in the cities of the developing world, a global climate deal should (a) increase the amount of international funding for urban adaptation, especially in LDCs; (b) multiply opportunities for channelling carbon financing into urban green growth; (c) make international financial support dependent

on innovative national urban policies; and (d) support urban learning, networking and knowledge-sharing programmes.

1 Diversity and complexity of cities in the developing world

Globally, cities currently account for 80% of GDP production and over 70% of GHG emissions, while hosting 54% of the world's population. As in the rest of the world, cities in developing countries and emerging economies concentrate population and economic assets, and contribute disproportionately to their countries' generation of wealth. As urban agglomerations attract national production, consumption, and provide transit for incoming and outgoing goods, they are also the centres of highest energy usage and therefore of highest GHG emissions. With the share of global GDP being increasingly generated elsewhere than the G20 countries, an ever-greater share of emissions will originate from cities in emerging economies in the near future.

As international negotiations are approaching the 21st Conference of the Parties in Paris, a global framework agreement to counter climate change should be shaped so that cities become fully engaged in its implementation. For this to happen, it is imperative to recognise the diversity and complexity of the urban settlements in developing countries and emerging economies, and to unpack the generic concept of 'cities of the global South' in order to engage them more effectively in climate action.

While GDP per capita is a coarse measure of wealth and welfare, it is still helpful in decoding the specific climate change challenges that various types of developing and emerging cities are already facing and will increasingly face in the future. Cities in least developed countries (LDCs) are likely to present a profile of low energy usage, accompanied by low GHG emissions levels, but a high level of urban risk and exposure to climate change impacts. This, in turn, is the result of a low level of infrastructure provision, a high percentage of the resident population living in informal housing, unmitigated natural hazards, and a low institutional capacity to manage urban growth as well as enforcing urban planning legislation, providing basic urban services and emergency response systems (Revi et al. 2014).

At the other extreme of the spectrum of cities in the developing world we find the complex urban agglomerations of Upper Middle Income Countries, with sophisticated modern infrastructure, generalised formal housing, high energy usage and high GHG emissions levels. These are in many cases boosted by the intensive export-oriented manufacturing activities that have displaced industrial production from Europe, North America and Japan. However, depending on their location (but especially if located in coastal zones), many such cities may be also exposed to high levels of unmitigated urban risk and vulnerable to climate impacts.

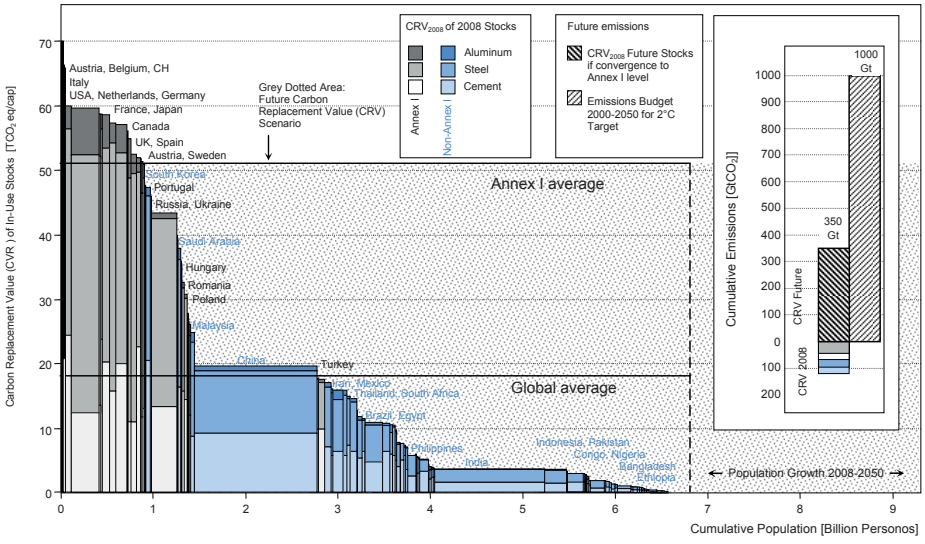
2 Combined challenges of future urbanisation and climate change

Cities have become the dominant form of human settlement on the planet, with urbanisation galloping ahead at a much faster rate than global population growth. This 'great acceleration' is in its overwhelming majority taking place in the cities of developing countries and emerging economies, where over 2.3 billion new residents are expected out of a global forecasted population increase of 2.5 billion by mid-century. The regional distribution of urbanisation will be uneven, with the vast majority expected to take place in Asia and Africa. By mid-century, the urban population of Africa is likely to triple and that of Asia to increase by over 60%. Future increases in the world's urban population are also expected to be highly concentrated in just a few countries. Taken together, China, India and Nigeria are projected to account for 37% of the increase of nearly 2.5 billion people in the urban population by 2050 (UN DESA 2014).

The relationship between urbanisation and economic growth is also very varied, and while the two are historically strongly correlated, in LDCs and in Africa in particular they appear to follow quite separate trajectories. The economies of many African cities may continue to stagnate or grow very slowly, putting additional strains on infrastructure, housing, welfare, and governance. An increasing proportion of urban informality will be the unavoidable consequence of further urbanisation with little or no economic growth, further exposing resident populations to urban risks and depriving them of the improved welfare generally associated with urban life.

Two trends, however, are common to all fast-paced global urbanisation in the 21st century: sprawl (i.e. the increase of the urban land footprint per inhabitant), and an increasing consumption of natural resources and energy for the production of buildings and urban infrastructure. If unmitigated, both have significant implications for the future trajectory of GHG emissions growth. Urban sprawl locks in greater distances between functional city locations, greater infrastructure and energy requirements, and ultimately creates a higher dependency on fossil fuels to keep urban systems operational, while causing labour productivity losses. The construction of the built environment represents huge commitments of natural materials, their extraction, processing and transport, with related energy consumption and emissions outcomes (Seto et al. 2014). These become the 'stocks' of emissions embedded in the built-up cities versus the 'flows' from recurrent or yearly urban energy usage, the only ones to be accounted for in standard urban emissions inventories.

Figure 1 Carbon replacement value per capita of existing stocks by country and as yet unbuilt stocks if developing countries converge on the current Annex I level



Source: Figure 12.12 in IPCC (2014), using data from Müller et al. (2013).

As illustrated in Figure 1, the carbon replacement value (CRV) for reference year 2008 (CRV2008) of key building materials (aluminium, steel and cement) currently embedded

in the national building stocks varies greatly, and is largely correlated to per capita GDP. The average CRV for Annex I countries has been calculated at 50 tCO_2eq/capita. Were that average of carbon intensity to be reached by all expected future construction and urban build-up by mid-century, one third of the available carbon budget (1,000 Gt CO_2) would be consumed (with 75% probability). Of this overall emissions budget for the planet to remain within the 2°C temperature increase, approximately 420 $GtCO_2$ have already been emitted during the period from 2000 to 2011.

Table 1 Emerging cities will play a significant role in growth of the global economy and carbon emissions to 2030

Urban group	Projected base GDP growth from 2012–2030 (US$ trillions)	Projected base case emissions growth from 2012–2030 (Mt CO_2)	Projected population in 2030 (BNS)	Per capita in 2030 (tonnes of CO_2 per person)
Emerging cities e.g. Bangalore, Kunming, Pune, Puebla	16	3,230	~1.3	~7.0
Small urban areas inc. villages, small towns, peripheral industrial areas pop. < 0.5 million	16	1,220	~2.2	~4.6
Established cities e.g. Stuttgart, Minneapolis, Stockholm, Hiroshima	11	390	~0.4	~12.1
Global megacities e.g. Beijing, New York, London, Rio de Janeiro	10	1,050	~0.6	~7.1
Total growth	~52	~5,890	Total population in 2030 ~4.5	
Share of world growth	~87%	~65%	Share of world population in 2030 ~4.5	

Source: Figure 2 in GCEC (2014).

In the analysis of the Global Commission on the Economy and Climate, "emerging cities will play an increasingly significant role in growth of the global economy and carbon emissions to 2030. Already in 2014 the GDP generated by China's ninety largest cities amounted to over US$6 trillion, the equivalent of Germany and France's economies combined". Under a business as usual (BAU) scenario, 468 cities will account for over

60% of global income growth over the period 2012-2030, and for nearly half of energy related emissions growth (GCEC 2014).

The subset of 291 'emerging cities' (rapidly expanding, middle-income, mid-sized cities in China, India and other emerging economies) is likely to account for over a quarter of global income growth (US$16 trillion) and over a third of global energy-related emissions growth (3,230 Mt CO_2) over the period 2010-2030. According to the Global Commission, action by this group of cities represents the most significant short- to medium-term global opportunity for avoiding lock-in to long-lived high-carbon urban infrastructure.

'Small urban areas' will account for a similar amount of income growth, but for a significantly lower growth in emissions of about 1,220 Mt CO_2 by 2030. This is consistent with the projected increase of urban centres with a population below 100,000, in which 40% of the world's population are supposed to reside by mid-century. Another 21% will reside in cities of between 100,000 and 1,000,000 inhabitants. This is where much of the urbanisation in LDCs will take place. The lower level of emissions growth in small urban areas is explained by their regional location and by agglomeration dynamics, which concentrate manufacturing and infrastructure in larger urban centres. Governance and institutional capacity are scale and income dependent, i.e. they tend to be weaker in smaller cities and in low-revenue settings. However, as the bulk of urban growth momentum is expected to unfold in small to medium-sized cities in the developing world, significant opportunities for GHG emissions reductions might be precisely in those urban areas where governance and institutional capacities to address them are weakest (Seto et al. 2014).

Cities in general, and particularly those in the developing world, are subject to a number of specific impacts of climate change: ambient temperature rise amplifies the urban heat island effect and generates heat waves, with severe consequences for the resident population, particularly the young, the elderly and the vulnerable; higher temperatures interact with air pollutants and worsen air pollution; more sudden and intense episodes of precipitation overwhelm drainage systems and multiply urban flooding risks; coastal erosion, storm surges and sea level rise threaten wetlands, riverine outflows, as well as seaboard infrastructure and housing in many locations already exposed to land subsidence; and finally, the provision of drinking water is impacted by climatic strains

on the resource base. Such impacts are expected to increase significantly by mid-century and onwards, depending on the future trajectories of emissions and of related global warming.

With urbanisation unfolding at such a rapid pace, increasing amounts of urban population, infrastructure, built environment and economic assets will be exposed to these impacts. As cities grow, and especially where urban expansion is not mastered or controlled but is purely driven by demographics and agglomeration economics, they eventually occupy areas at greater risk, be they exposed to intense flooding and landslides, typhoons or hurricanes, or below sea level. This is especially relevant for the low-income, informal settlements typical of LDCs, and for marginal neighbourhoods in middle-income countries.

3 Synergies of urban adaptation, development and resilience

The challenges of urban adaptation to climate change come on top of massive and as yet unmet development needs, especially in LDCs where often weak governance and limited financial and technical resources cannot match the fast pace of urbanisation and the increasing demands for basic urban infrastructure, shelter and welfare. Investments aimed at favouring growth and the productivity of urban agglomerations are required in order to provide the economic and fiscal basis for further urban expenditures. Against this backdrop, LDC governments often perceive urban adaptation as an additional exogenous burden caused by the cumulative historical GHG emissions of wealthier nations. Adaptation is rarely considered as a short-term priority, also in view of the high level of unmitigated exposure to natural hazards that many cities in the developing world are facing. Finally, the limited availability of financial resources for climate adaptation hampers much needed urban responses.

However, urban climate adaptation can be synergistic with investments related to natural hazard risk mitigation, the provision of basic infrastructure, the protection of the urban environment, and the improvement of welfare for the resident population, especially the poor. When such synergies are obtained, adaptation can be more easily mainstreamed in the strategic investment plans of the rapidly urbanising cities of the

developing world. Climate change impacts can be mitigated via pre-emptive actions, rather than in a more costly, disruptive and less efficient emergency response modality.

For instance, Durban in South Africa "has adopted and is implementing an eco-systems based adaptation strategy, including a large-scale community reforestation programme where community level '*tree-preneurs*' produce indigenous seedlings and help plant and manage the restored forest areas as part of a larger strategy to enhance biodiversity refuges and water quality, river flow regulation, flood mitigation, sediment control, and improved visual amenity. Advantages include employment creation, improved food security, and educational opportunities". Also, "[i]n Quito, where reduced freshwater supplies are projected with glacier retreat and other climate-related changes, local government has formulated a range of adaptation plans, including encouraging a culture of rational water use, reducing water losses, and developing mechanisms to reduce water conflicts" (Revi et al. 2014).

The benefits of adaptation can therefore be measured not only in terms of avoided damages and losses that would be inflicted on a given city by the impacts of climate change, but also in terms of additional improvements to the overall quality of the agglomeration to be obtained via such investments. For instance, the protection of certain areas from increased risk of flooding and mudslides may result in the upgrading of informal neighbourhoods, with significant social benefits; the management of larger volumes of runoff can lead to the protection of wetlands and waterways with amenity co-benefits for all residents; planting green canopies over central streets may reduce the impact of the heat island effect and of heat waves, while also providing the city with more greenery and more liveable public spaces; a coastal defence project may include the creation of a sea-front promenade and its costs may be offset by increased real estate values and the benefits of waterfront regeneration. Adaptation to climate change can thus become embedded in sustainable urban development and generate further rewards.

4 Synergies of urban mitigation, green growth, and welfare

Similar considerations apply to the task of reducing GHG emissions from cities in developing countries and emerging economies, starting with those that have taken

over the bulk of worldwide manufacturing and that are expected to grow the most in population, urban footprint, GDP, energy usage and GHG emissions in the next decades. The green growth paradigm seems to provide the best possible approach to achieve substantial reductions to projected GHG emissions from these cities, and more.

For cities that are expected to add significant amounts of built environment between now and mid-century, the challenge and the opportunity lie in embracing a low-carbon urban development framework, delinking economic growth from energy intensity and energy production from fossil fuels. Important synergies are also to be found between carbon reductions and improvements in urban air quality and related public health and urban welfare, which are much sought-after by residents of large developing and emerging cities. The synergies of air pollution reduction and GHG emissions abatement are significant and may provide the necessary public support for the climate change mitigation agenda.

In the words of the Global Commission on the Economy and Climate, "[n]ew analysis … suggests that the United States could save $200 billion per year if it pursued smarter, more compact growth policies, primarily due to savings in the cost of providing public services and capital investments such as roads. According to the World Bank, China could save up to US$1.4 trillion in infrastructure spending up to 2030 if it pursued a more compact, transit-oriented urban model – equivalent to around 15% of China's GDP in 2013. Analysis for the Commission suggests that more compact, connected urban development could reduce global urban infrastructure requirements by more than US$3 trillion over the next 15 years (2015-2030)" CGEC (2014: 11).

Compact urban growth, connected infrastructure and coordinated governance are the three 'Cs' recommended by the Commission to reduce urban investment requirements, capture productivity gains, abate GHG emissions, significantly improve the quality of urban environments for their resident populations, and lighten the load of cities on natural ecosystems. The IPCC's Working Group III recommends a sustainable low-carbon urban morphology based on density, land-use mix, connectivity and accessibility (Seto et al. 2014).

A similar approach has been tested by urbanist Peter Calthorpe in simulating alternative urban growth and GHG emission scenarios for the United States. Based on current

estimates, 60 million new units will have to be added to the housing stock by 2050. The BAU or 'trend sprawl' scenario would increase urbanised land by 38%, and require about US$50,000 per unit of on-site infrastructure alone. In a 'simple urbanism' scenario the demand for urbanised land would be slashed by two thirds, and the costs of on-site infrastructure by half. The increased density and lower infrastructure costs would be achieved by altering the mix of single-family, multi-family homes and town-houses, which would represent 55%, 31% and 14% of the additional stock, respectively, against 67%, 23% and 10% of the BAU scenario. The 'green urbanism' scenario, which would complement compact land-use with aggressive standards for mobility, fuel-efficiency, building efficiency and building retrofits, and high contributions of renewables to energy generation, would reduce additional GHG emissions by three quarters and air pollution by half (Calthorpe 2010).

Compact urban growth is thus articulated to achieve urban quality, encourage mass transit and non-motorised transportation, and create urban environments of high livability, in addition to the pursuit of GHG abatement. In the developing world, Curitiba in Brazil has been the regional pioneer for transit-oriented development since the 1970s, and its example has been followed by a number of more recent large-scale urban retrofits of mass transit systems, such as Bogotá's *Transmilenio*, which have contributed to limiting traffic congestion and air pollution, increasing labour productivity, reducing GHG emissions, and improving public health and quality of urban life in various Latin American cities.

Thus, the benefits and costs of carbon mitigation need not be measured only through dedicated GHG abatement cost curves, but rather as part of broader assessments of green growth yielding multiple parallel benefits as a result of sustainable urban strategies.

5 New urban policy directions, innovations, and city learning

In the previous sections of this chapter, adaptation and mitigation, as well as their respective linkages with sustainable urban development and green growth, have been addressed separately. However, recent urban practices worldwide are demonstrating that the most successful urban climate policies integrate the adaptation and mitigation

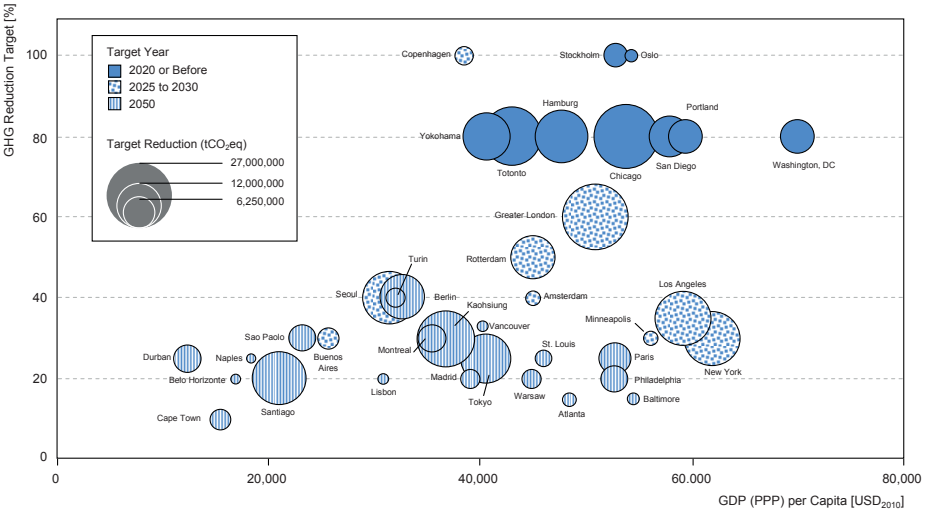
agendas. Many Climate Actions Plans – the 'road maps' that urban governments prepare in order to embark on, and then monitor, their strategies for climate action – include investments for adaptation as well as for mitigation, and many such actions naturally converge.

For instance, investments in providing a higher level of thermal insulation of the building stock, whether via the construction of green buildings or retrofitting existing ones, will certainly provide adaptation to a warmer climate, but will also mitigate GHG emissions on account of lower building energy usage. Green infrastructure meant to manage excessive, sudden runoff and to provide protection against flooding will also generate urban cooling comfort and absorb carbon emissions. Effective waste management and recycling will provide protection of urban waterways and public spaces from uncontrolled dumping, but also methane sequestration and a reduced consumption of natural resources.

Many cities in OECD countries have been generating substantive innovations by internalising the climate change agenda and making it an opportunity for countercyclical economic investments, urban renewal, job creation, jumpstarting the urban green economy, and developing specific and exportable know-how on managing cities in a warming world. Some cities have already achieved deep cuts in local GHG emissions and have increased their resilience and adaptation to climate change impacts. Urban commitments to mitigation often surpass the ones of national governments, showing that cities can lead the way forward.

As illustrated in Figure 2, some cities such as Copenhagen, Stockholm and Olso are 'ahead of the curve' and are showing that the urban economy can be entirely decarbonised, and indeed have committed to do so by 2030 or by 2050. Such cities clearly benefit from a high GDP per capita, a long-standing commitment to environmental sustainability and urban quality of life, a pro-active policy environment and supportive populations. Their mix of GHG abatement solutions includes compact urban form and density, non-motorised transportation and mass-transit systems, energy efficiency of the built environment, on-site and off-site renewables, heat and energy co-generation from waste management, as well as carbon offset programmes. Their examples pave the way for more urban innovation globally.

Figure 2 Mitigation targets for 42 cities



Source: Figure 12.21 in IPCC (2014); baseline emissions, reduction targets, and population from self-reported data submitted to Carbon Disclosure Project (2013).

In the EU's policy context, the Covenant of Mayors was set up in 2009 as a voluntary network of local governments committed to the EU goal of a 20% reduction in GHG emissions by 2020 over the 1990 baseline, with 20% of renewables in the energy mix. With vast control over local infrastructure, built environment construction regulations, waste management, and utility provision, city and regional governments are best suited to assess local energy usage, formulate GHG reduction strategies, and mobilise civil society and private-sector actors. Over 6,000 local governments representing 200 million citizens have signed on to the Covenant and are currently implementing emissions abatement programmes, many of which promise to surpass the EU-wide stated goal.

Not many cities in the developing world have gone as far, although some champions have emerged and many adaptation and mitigation projects are currently being implemented. Cities like Mexico City, Rio de Janeiro and Medellin in Latin America, Amman in the Middle East, Bangkok, Jakarta, Beijing and Shanghai in East Asia, Addis Ababa and Durban in Africa, Mumbai and Dhaka in South Asia, and many others are tackling climate change challenges. The plethora of developmental priorities that cities in the developing world have to contend with, as well as the limits to financial and technical

resources available, constrain the extent to which climate change has been addressed so far.

Over the past decade there has been a great increase in development assistance for urban climate change mitigation and adaptation by numerous multilateral and regional banks and agencies. They provide financial resources and technical assistance for specific investments, as well as for urban risk assessments, citywide emissions inventories and the development of low-carbon strategies, as well as for the expansion of carbon markets. Their support, as well as that of some key foundations, also facilitates the transfer of innovations from OECD cities to developing and emerging cities. Research programmes in major universities worldwide have generated a rich literature of case studies on the specifics of urban climate change, better informing urban decision making.

Some major international city networks have emerged, such as ICLEI and C40, which focus their work on policy and experience sharing and on providing assistance to their members for urban climate action planning and implementation, including in the cities of the developing world. Working through effective mayor-to-mayor collaboration, they play an invaluable role in prompting innovations, facilitating exchanges, and raising the priority of urban climate change action worldwide.

6 An international framework in support of resilient and low-carbon cities

Paradoxically, despite the finally prevailing view that cities are 'part of the solution' and not only 'part of the problem' in the global fight against climate change, they do not have any official role or 'seat at the table' in the context of international negotiations. These are conducted within the UNFCCC by national governments and their delegations. The Compact of Mayors, the World Mayors Council on Climate Change and other municipal networks have emerged in the past decade to ensure that the essential voice of cities is heard at the negotiations and beyond. Going forward, INDCs should clearly report their urban components so that the contributions of cities in mitigating GHG emissions may be internationally accounted for and recognised for the importance they have in meeting this global challenge.

The ongoing momentum of climate action in cities can be greatly boosted by a framework agreement at the international level, especially if it contains specific provisions to engage and support cities in the developing world, based on their specific characteristics, challenges, constraints, GHG emissions levels and climate vulnerabilities. Below are four recommendations on how an international framework agreement could provide support:

1. **Increase the amount of international funding for urban adaptation, especially in LDCs**. This could allow many cities critically at risk of climate impacts to carry out essential investments in coastal protection, flood control, water supply and other priority areas. The Green Climate Fund should provide the funding; multilateral and regional development banks should be the delivery vehicles and provide the related technical assistance, as they are engaged with assisting cities with infrastructure investments.
2. **Multiply opportunities for channelling carbon financing into urban green growth**. The growing relevance of emission trading schemes and carbon pricing already includes cities in the OECD as well as emerging economies. For cities to better participate in carbon markets, carbon emissions reductions originating from many urban sectors should be integrated and certified. The Global Protocol for Community-scale GHG emissions is becoming the internationally recognised standard and should be further endorsed.
3. **Make international financial support dependent on innovative urban policies**. Policy guidelines should ensure that financial resources for urban climate action integrate adaptation with sustainable urban development, and mitigation with green growth policies. Technical assistance for urban risk assessments and emissions inventories should be multiplied to develop optimal strategies, as the basis for political support and financing. Private sector actors could be further engaged in providing know-how.
4. **Support international learning, networking and knowledge-sharing programmes**. The voluntary efforts of membership-based associations need to be

supported financially as they can greatly accelerate the up-take of climate action in the developing world's cities. Specific knowledge-sharing programmes on metropolitan governance, climate-friendly fiscal policies and creditworthiness can facilitate the access of cities in emerging economies to capital markets and make their climate strategies more effective.

References

Calthorpe, P. (2010), *Urbanism in the Age of Climate Change*, Washington, DC: Island Press.

Carbon Disclosure Project (2013), *CDP Cities 2013: Summary Report on 110 Global Cities*, London.

Global Commission on the Economy and Climate (GCEC) (2014), *The New Climate Economy: Better Growth, Better Climate*.

IPCC (2014), *Climate Change 2014: Mitigation of Climate Change* (see IPCC (2014b) in the introduction to this book for the report's full reference).

Müller, D.B., G. Liu, A. N. Løvik, R. Modaresi, S. Pauliuk et al. (2013), "Carbon Emissions of Infrastructure Development", *Environmental Science & Technology* 47: 11739–11746.

Revi, A. , D. E. Satterthwaite et al. (2014), "Urban areas", in *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (see IPCC (2014a) in the introduction to this book for the report's full reference).

Seto, K.C., S. Dhakal et al. (2014), "Human Settlements, Infrastructure, and Spatial Planning", in *Climate Change 2014: Mitigation of Climate Change* (see IPCC (2014b) in the introduction to this book for the report's full reference).

UN DESA (2014), *2014 Revision of World Urbanization Prospects*, New York: United Nations.

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